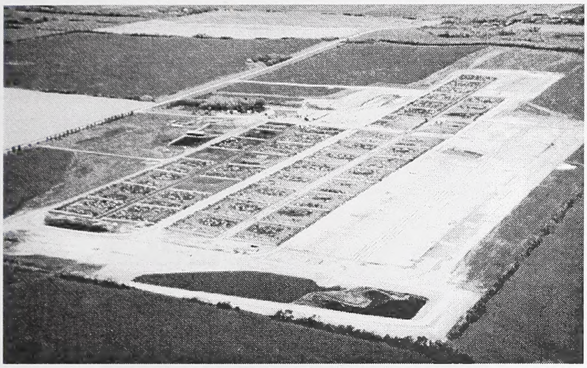
THE
ENGINEERING IN AGRICULTURE
NEWSLETTER

SPRING 1999

Feedlot Runoff Study Completed

Brian Kennedy, Agricultural Engineer, Vegreville



Highland Feeders Ltd. (north of Vegreville) was the site of a feedlot study which characterised pen runoff quantity and quality from an operating beef feedlot in Alberta's parkland. The study ran from 1994 to 1996 and during this time, the feedlot population increased from about 12,000 to 25,000 head. Its main objectives were to:

1. Measure the runoff volumes resulting from rainfall events at the feedlot site.
2. Measure chemical parameters in the runoff including, but not limited to, pH, calcium, sodium, potassium, chloride, COD, TKN, NH_3-N, and phosphorus.
3. Measure microbiological parameters including heterotrophic plate count, faecal coliforms, and faecal enterococci.

As part of the study, an extensive literature review was conducted. It provided a conceptual model of a feedlot floor as an impervious layer, overlaying a sponge-like material that soaks up water from a rainfall or snowmelt event before runoff begins. The literature review indicated that a settling basin was required in front of the runoff retention basin to remove transported solids from the runoff. Feedlot runoff contains a variety of plant nutrients and salts. Utilization of the runoff collected must consider the effects of salts on the crops and soils to which it is applied. High irrigation rates can result in the build up of salts in the soil with subsequent soil damage and reduced cropping choices.

Runoff was collected and analysed from four groups of pens in the feedlot (two were developed during the study) and from the runoff holding pond. A soils investigation was conducted to estimate infiltration through the feedlot floor. The land area, where the runoff was applied by irrigation, was monitored for microbiological die-off and chemical changes. Here is a summary of the results.

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Alberta
AGRICULTURE, FOOD AND RURAL DEVELOPMENT
Engineering Services

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The purpose of this newsletter is to advise of activities and projects being conducted by Alberta Agriculture, Food and Rural Development's Engineering Services and Regional Agricultural Engineering staff. For further information on these projects and other engineering related activities contact:

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Hydrology: During the period of study, two types of storm events were observed: short duration high-intensity storms, and long duration low-intensity storms. The first type of storm produced a small amount of runoff immediately. The second type produced runoff after a time delay of about 24 hours. During this time delay, the surface of the feedlot absorbed moisture. Runoff began when the surface was saturated (approximately 25 mm of rainfall required). Runoff yield from rainfall events in this study ranged from 22.8 percent to 73.3 percent of the precipitation that fell on the pens. Snowmelt runoff was not measured. A pen management strategy was implemented to remove frozen manure and snow, prior to the spring thaw. This produced dry pens in a short time period.

Chemistry: Runoff samples were collected and analysed for selected chemical parameters. In general, average chemical concentrations and suspended solids were higher in the runoff than in the runoff storage pond. Chemical concentration at the beginning of runoff was low, increased for a period of time, and then stabilized for the rest of the event.

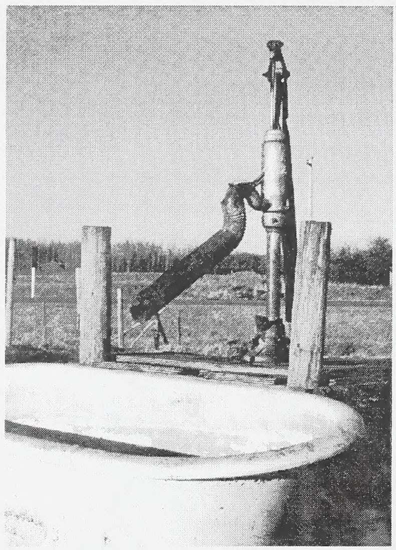
Microbiology: Heterotrophs, faecal enterococci and faecal coliform bacteria were measured in runoff and the runoff storage pond samples. A surprising result was the similarity of bacterial numbers found in the runoff from a new site that never had cattle when compared to the levels found in the nearby active pens.

Conclusions

1. Holding pond size depends on total yearly rainfall at the site and on the management practices of emptying the stored runoff. Sizing criteria for catch basins has focused on severe single event storms. In light of the runoff characteristics of feedlot pen soils, and the typical annual one-time emptying of catch basins, an alternative design method is suggested. Runoff yields of a critical wet year may represent more appropriate data for design requirements.
2. A protocol for land application of stored runoff is needed. This protocol must consider runoff chemistry, soil chemistry, plant uptake of nutrients, and sensitivity of sodium loading.
3. Manure removal and pen scraping should not disrupt any impervious layers that have developed at the base of the manure pack.
4. Feedlot runoff contains a number of plant nutrients and sodium. The levels found in the runoff were variable, both during the year, within storm events, and between years.

A New *Water Act* for Alberta!

Murray Tenove, Water Quality Engineer, Edmonton



A cornerstone of the engineering services that Alberta Agriculture, Food and Rural Development (AAFRD) has provided over the years is to assist agricultural enterprises and rural residents in constructing and maintaining safe and secure water supplies. So it is no surprise that AAFRD engineers and technologists are involved in the implementation of the new *Alberta Water Act,* which came into effect on January 1, 1999. To gear up for the questions, concerns, and opportunities that come with a legislative change, our water related information, recommendations, and displays have been revamped.

You might ask why we chose to communicate information about legislation regulated by Alberta

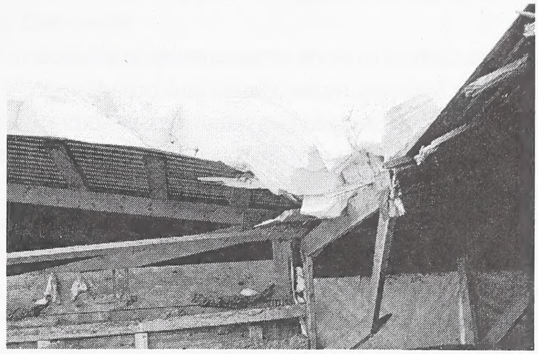
Environmental Protection (AEP) here. Well, for one thing, there is a great opportunity for agricultural producers to register their historic water use **at no cost** in a newly created "Traditional Agriculture Use" category. While it doesn't hold the highest priority that a "Household Use" does, it allows the province to document when the water source was first used. What does that mean to a producer? Your earliest water use will go on provincial record and in times of water shortages or new developments applying for a water license, your use has to be accommodated. The earlier the date applied to your record, the more priority you hold over other licensed or traditional agriculture water uses. Under the "Traditional Agriculture Use" category producers, who own the land where the water source resides, can register up to 6250 cubic metres (1.375 million imperial gallons) annually for traditional purposes. Under the *Water Act*, these purposes are specified as water used for raising animals or applying pesticides to crops. Larger uses of water, such as irrigation, will still come under a license.

The opportunity to register "Traditional Agricultural Use" doesn't last forever. This window is open until December 31, 2001, and since agricultural producers have the most to benefit or lose, AAFRD has agreed to assist the registration process which starts on April 1, 1999. Client Service Representatives (CSRs) in all our AAFRD district offices have been trained to help fill out the registration forms and send them into AEP. We, as technologists and engineers that regularly deal in the sourcing and security of water, are anticipating increased requests for technical assistance and advice. Fortunately, we have recently geared up in complimentary areas. As our previous issue of this newsletter documented, we have filled three new water specialist positions and three new engineering positions dealing with intensive livestock siting. We can be contacted through the CSRs that help you register. Feel free to ask for useful publications such as *Water Wells that Last for Generations* or other water related factsheets. You can view the new *Water Act* in its entirety on the Queen's Printer web site (www.gov.ab.ca/qp).

When The Roof Caves In

Dennis Darby, Structures Engineer, Lethbridge

Are your farm buildings insured against collapse due to excess snow loading? Are you sure about that? Better check the fine print and confirm this with your insurance agent. Even if you are covered, some restrictions may apply.



Every winter when there are building failures, some owners learn a little too late that their insurance does not cover collapse due to snow load. Most insurance information bulletins deal mainly with fire safety and loss prevention; rightly so, as this is the major cause of insurance claims in Canada. There is little information regarding snow loads and adequate structural design. Property insurance has many complex issues. Here are some examples on the subject of roof failures.

Many insurance policies exclude "collapse due to weight of snow and ice", or a statement similar to this. For a small fee, this peril has to be specifically added in. Wind damage may also fall into this category. Even when snow load coverage is provided, an insurance claim could be denied for a variety of reasons. The most common is that the building is substantially under designed, or has serious construction errors. Insurance coverage may also be denied if there has been wood decay or corrosion of truss gusset plates due to excess moisture in the attic. This is often discovered only after the building fails and an investigator has assessed the cause and mitigating factors.

Some recent examples are worth noting. One case involved a building that collapsed under a normal

snow load. Someone had rafters designed for a 24 inch spacing but "economized" by placing them at a 48 inch spacing - insurance denied. Another building was denied an insurance claim when it was revealed that the truss rafters were homemade with inadequate stapled gusset connections. One more case, still under investigation, registers a concern that the ventilation system caused moisture in the attic, severely corroding the truss plates.

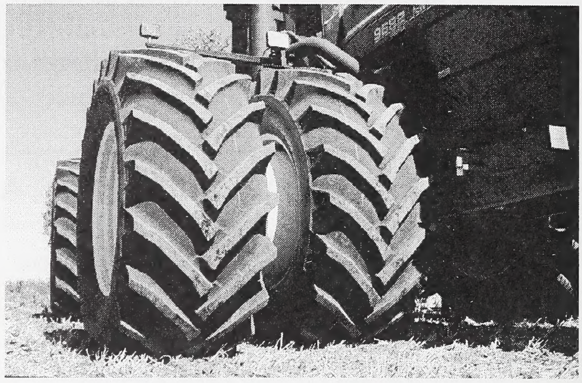
Large modern livestock structures have what the insurance industry terms a high and broad "risk exposure" - meaning losses can be more than just the replacement value of the building. Though farm buildings in Alberta are exempt from the *Building Code*, the insurance, lending, and farm building industries are taking more aggressive stands on requiring buildings to be designed according to *The National Farm Building Code*.

The bottom line is to know exactly what your insurance coverage includes. Ask for a "Plain English" explanation of what is covered and what is not. Make sure the buildings are built to *Code* and properly maintained.

What About Those Trelleborg Tires?

Reed Turner, Project Engineer, AFMRC, Lethbridge

Since their introduction to Canada in 1994, Trelleborg tractor tires have been aggressively marketed as replacements for radial tires. The company claims that the tires have higher efficiency, lower compaction, and none of the power hop concerns that radials have. In 1998, the Alberta Farm Machinery Research Centre (AFMRC) ran field tests to evaluate the Trelleborg claims. They compared a set of Trelleborg 750/65-38 dual tires to three sets of radial tires: 710/70 R38 duals, 20.8 R42 duals, and 20.8 R42 triples. Several companies, including Trelleborg, Goodyear, Firestone, John Deere, Flexi-Coil, and New Holland cooperated in the project.



The tire sets were tested across a wide range of soil conditions, power loads, weights, speeds, and pull levels. Power delivery efficiency, pulling ability, loading capability, power hop characteristics, floatation, ride quality and cost were also evaluated. Two complete sets of tests were run. The first set was done in the spring during typical wet conditions where traction and floatation were concerns. The second was run late summer during typical dry conditions where power hop could be a problem. Durability issues with the various tires were not addressed during the trials.

So how did the Trelleborgs stack up? The short answer is that they acted like the bias ply tires that they are. On the positive side, they showed no problems with power hop and could carry weights and transmit torques similar to radial tires. On the negative side, they operated at higher inflation pressures than some of the radials, pulled less for the same ballasted weights, and were a few percent less efficient. They also cost substantially more than radials or conventional bias ply tires.

How did the individual items rate? Consider the following table as a scorecard.

Test Performed	Better Product
Power Delivery Efficiency	Radials
Pulling Ability	Radials
Loading Capability	Radials
Power Hop	Trelleborgs
Floatation	Tie
Ride Quality	Trelleborgs
Cost	Radials

So what does this mean for producers? While Trelleborgs are one more traction option, they have both pluses and minuses to consider. Potential buyers need to weigh the positives of better power hop control and calmer ride against the negatives of higher ground pressure and lower efficiency to decide if the tires are worth the additional cost. For further information contact the Alberta Farm Machinery Research Centre at (403) 329-1212.

Protecting Your Well From Contamination

Ken Williamson, Agricultural Water Specialist, Red Deer

The most important resource on your farm is your well. It is also the most misunderstood and often taken for granted. Any neglected resource is a prime candidate for contamination. The biggest contamination threats come from things that we walk past or trip over every other day. Here is a list to keep in mind.

1. Poor well construction.
The fastest way to contaminate groundwater is to drill a poor quality well. Inadequate surface casings or formation seals can allow surface water to seep along the outside of the casing. Poor wells drilled through multiple aquifers can mix water from the various formations. The best protection is to hire a qualified, conscientious driller.

2. Old wells.
Old wells with poor construction or rusted out casings can contaminate good wells. Old wells need to be properly plugged from the bottom to the top with bentonite or cement grout.

3. Pump pits.
Pump pits can act as a funnel for contaminated surface water or shallow groundwater to enter a well, especially during spring flooding conditions. Pump pits should be replaced with pitless adaptors, or have a sanitary well seal installed.

4. Hydrants installed in a well or well pit.
Hydrants can produce a back-siphon which will draw contaminated water down the well. Remove the hydrant from these locations or use anti-siphon valves to reduce the risk.

5. Poor sewage systems.
Leaking septic tanks or cesspools will contaminate shallow wells.

6. Seismic shot holes.
Poorly plugged shot holes can be a direct conduit for surface water into the groundwater. New regulations (incorporated last fall) require that shot holes be plugged to a depth of one metre, with at least 40 cm of approved material (e.g. bentonite) on top of the plug. Above the bentonite, at least 60 cm of drill cuttings must be tamped in.

7. Over application of manure.
Manure that is applied to land at a greater rate than will be used by growing crops can result in nitrogen leaching into the groundwater.

Engineering Restructured

Rick Atkins, Head, Engineering Services Branch, Lethbridge

The Engineering Services Branch of Alberta Agriculture, Food and Rural Development (AAFRD) has recently been reorganized as part of the Department's move to structure itself along functional lines. What this means is that many of the Regional Engineering staff will be under the newly created "Technical Services Division". Under the leadership of Dennis Glover, this division will not only include the Engineering Services Branch (Provincial Engineers and the Alberta Farm Machinery Research Centre) but a new branch dedicated to confinement livestock. Led by Louise Starling, this branch will include siting and development, the impending compliance and regulatory functions, and a communications and liaison role. Staff moving into this branch are Brian Kennedy, Brian Koberstein, Bill MacMillan, Vince Murray, Andy Cumming, Darcy Fitzgerald, Orin Kenzie, and Ken Williamson. The compliance and regulatory portion of the branch is still under development. These new positions will not be defined or filled until the new *Livestock Development Act* is tabled this fall.

A second change, as a result of the reorganization, is the move of the Agricultural Value-added Engineering Centre (AVEC) from the Engineering Services Branch to the Processing Division within AAFRD. This work unit will be closely associated with the Food Processing Development Centre in Leduc. Staff effected include Marshall Eliason, Kris Chawla, John Chang, John Kienholz, Hong Qi, and Dr. Lope Tabil.

The structural changes will have little apparent impact on services to clients in the short term but will certainly improve the focus on emerging issues, integration of planning and programming, and improve the effectiveness of the various work units into the future.

Current Research Projects

Rick Atkins, Manager, AFMRC, Lethbridge

Its a new year and yet another busy season is underway at the Alberta Farm Machinery Research Centre (AFMRC). A variety of projects involving liquid manure injectors, windrow composters, tractor performance, and spraying systems are in full gear. Here is a brief sampling.

An evaluation and demonstration of windrow composting machinery on feedlot manure in southern Alberta will examine the mechanical effectiveness of aerating windrows with different technologies and methods. Mechanical effectiveness will be judged according to rate of work versus horsepower requirement relations; uniformity of end-product; biological heat produced during composting; windrow oxygen content before and after aeration; mass and volume reduction; and final product nutrient analysis. The results should help make recommendations on how to reduce costs and improve quality in composting operations.

Some of the current nitrogen fertilizer placement methods with double shoot openers include mid row banding, side banding, and side placement. As there is no consensus on their agronomic performance, the Research Centre will measure emergence and crop yields using the various nitrogen fertilizer placement methods. A new plot seeder will be used to meet the versatility demands in metering fertilizer and changing shanks and openers.

Research continues in the area of liquid manure injection. Projects will examine the distribution and injection rates for different liquid manure injectors along with draft measurement. Draft will be tested in the soil bin for several different depths and speeds. Contact the Alberta Farm Machinery Research Centre at (403) 329-1212 for further information.

CLVA - A Prototype User Interface Design

Robert Borg, Agricultural Engineer, Red Deer

CLVA (Canadian Livestock Ventilation Analysis), is a computer program that can be used as a tool to calculate heat and ventilation requirements of livestock barns. Written by Peter Clark, CLVA uses the latest research data regarding heat and moisture production of animals, including work done by John Feddes at the University of Alberta. The purpose of this project was to make the computer program "friendlier" by designing a new graphical user interface for it. Design criteria for the prototype interface was ease of use, the ability to quickly do many "what if" type of calculations, and to provide tools to answer in depth questions.

Potential users of CLVA are:

- Equipment suppliers, who will have a standard ventilation calculation for sizing equipment.
- Engineers and designers, who will have a tool for specific calculations including energy audits, effects of common walls, pre-heated inlet air, heat exchangers, infiltration rates, and the effects of various gases and animal productivities.
- Educators, who can use this as a learning tool to demonstrate ventilation principles.

Example: Calculate the heating and ventilation requirements for a 100' x 36' pig barn housing 500 - 50 kg pigs.

Enter the Animal Information: Open the program, pick the animal inputs tab and choose feeder pigs on the drop down menu. The program automatically enter 70% humidity, 3000 ppm CO_2 and 2.2° C summer temperature rise. The values have been set in preferences and can be changed if desired. Enter 500 pigs at 50 kg. The program enters 18° C as the inside temperature. A comfort zone button is available for more detailed calculations for indoor temperature if you have different animal sizes, floor temperatures, air speeds or feeding levels.

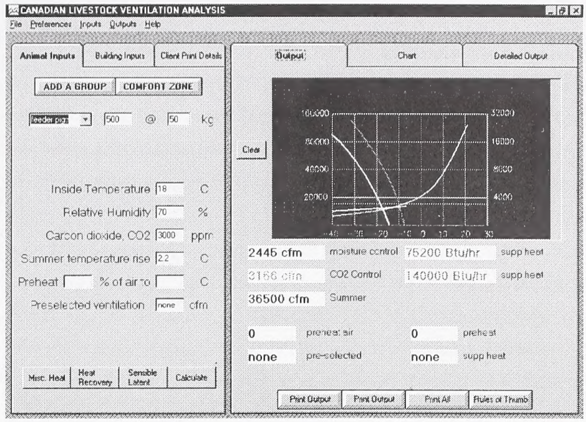


Figure 1 Animal input page with output showing summer and winter air flow rates, heating requirements.

Enter the Building Information: Pick the building input tab. Enter the room length of 100 ft. and room width of 36 ft. A ceiling height of 10 ft. is entered by the program as is the choice of standard rectangular building with R20 wall, R30 ceiling, and R5 foundation insulation values. Now you have entered four values - 500 pigs at 50 kg and building dimensions of 100 ' x 36 '. The program is ready to calculate.

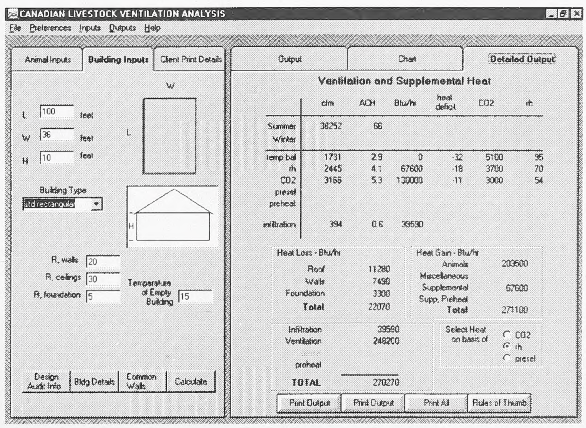


Figure 2 Building input page and detailed output page.

Calculate the Ventilation Rate: Click the calculate button on any of the input pages. The program calculates heat and ventilation, and

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displays the results on three pages; a page showing summer, winter air flow rates and heating requirements, a page showing a detailed ventilation chart from -40° C to +30° C or , a detailed output which shows you choices of various ventilation strategies. You can now change any number - insulation values, inside temperature, add windows and doors, etc. A dialogue box is available to show how your rules of thumb compare to the calculated air flow rates.

The second phase of this project will be the actual programming of CLVA to use this interface, then to include possible other modules such as building odour dispersion and barn equipment selection.

ILO Development Requires Advanced Decision Tool

Murray Tenove, Water Quality Engineer, Edmonton

When an intensive livestock operation is proposed in Alberta, a number of processes kick into gear to assure that the new development is environmentally acceptable and fits the development strategy for an area. Local governments have their own development permit processes and often call upon key engineering staff within AAFRD for their expertise. There are many variations to their involvement and who they are working with, but one thing remains constant - there are a lot of underlying factors that come into play. Many of these are site specific and require information about the land and water resources that are present. Information about these factors can be contained in many places, such as:

- aerial/satellite photography,
- hydrogeological maps,
- surficial geology maps,
- groundwater information,
- surficial water information,
- county maps (surrounding land use),
- soils maps/surveys,
- *Code of Practice* guidelines.

This information needs to be assembled as quickly as possible so that the time they have available can be concentrated on field investigation and analysis, regardless of the time of year. The ability to access all the pertinent information in an organized and timely fashion will result in the best possible recommendation being made. This can save many stakeholders a lot of time, money, and frustration down the road, while protecting public interests.

Fortunately for this purpose, technology has matured to the point that computerized decision support tools are readily available. But isn't the requirement for friendly access to this information common among many agencies and private enterprises? Yes - and there are many with less or more expertise and investment in it than AAFRD. So the ability to share (beg, borrow, or build) information is a key component of developing a good support tool.

Over the winter, the Engineering Services Branch, other AAFRD staff, participating agencies (PFRA, AEP), and some municipalities took part in a business area analysis to discover available resources and develop a plan to produce the best decision support tool. GSD and Associates Ltd. was hired to assist us in this process.

The first phase of the project was the Application Discovery phase. A number of workshops and interviews were held in which information regarding business processes, information sources, and other aspects of the business were collected. The second phase (Framework Design), assimilated the collected information into a set of three component architectures:

- Applications Architecture - how technology can support the business needs.
- Data Architecture - what information is available and how useful it might be.
- Technology Architecture - current and required hardware/software and programming needs.

The end result is a quality and defendable analysis. Now the real work begins and by this time next year we should have increased and broadened our capabilities within AAFRD tremendously to serve the need of an increasing and environmentally sustainable agricultural industry in Alberta.